## The New Compressed Air Wind Tunnel at the National Physical Laboratory

THE new compressed air tunnel for aeronautical research at the National Physical Laboratory, recently completed and now being brought into use, is the largest and most up-to-date of its kind, and the second one only in the world. A small tunnel on the same principle has been working in the United States for several years, and the British one has incorporated in it many new features found desirable during the use of this earlier type.

The theoretical basis of the new compressed air tunnel at the National Physical Laboratory is to be found in Rayleigh's law of dynamical similarity, upon which the validity of all model research in aerodynamics rests. This law may be written

$$R = \rho v^2 l^2 f(vl/\nu)$$

where $R$ is any particular aerodynamic reaction, for example, the lift or the drag of a model aeroplane, $v$ is the relative speed, $\rho$ is the air density, $l$ is a characteristic length of the model, $\nu$ is the coefficient of kinematic viscosity of the air, and $f(vl/\nu)$ represents some function of $vl/\nu$ which cannot be determined theoretically. The implication of this law in predicting full-scale characteristics from model tests is obvious. Thus if the model is tested at atmospheric pressure and temperature, the only way to be absolutely certain of predicting full-scale forces accurately is to test at the same value of the product $vl$.

A simpler approach to tests under these conditions, except in the matter of size, is seen in the very large wind tunnel, having a jet measuring 60 ft. × 30 ft., recently erected in the United States. Testing on such a large scale is very convenient for some purposes, but for most branches of research it is preferable to work with smaller models. In many cases the variation of the function $f(vl/\nu)$ with scale is not serious, so that tests in an ordinary atmospheric pressure wind tunnel of moderate size give all the accuracy required. Ample justification for ignoring changes in $f(vl/\nu)$ between tunnel and full-scale has now been provided by the agreement between full-scale flying measurements and model results obtained in such tunnels. But in some instances, notably the maximum lift coefficients of aerofoils, there may be a pronounced 'scale effect', that is, change in $f(vl/\nu)$ with scale or speed. It is here that Rayleigh's law provides a relatively simple solution, for the quantity $\nu$ varies inversely as the pressure, so that if the air is compressed to $n$ atmospheres, the model scale by speed product can be reduced in the ratio $1/n$ without affecting the value of $f(vl/\nu)$. This principle is made use of in the new compressed air tunnel, in which the air can be compressed to 25 atmospheres. The maximum wind speed in the six-foot diameter jet is about 60 miles per hour, so that tests at full pressure on a 1/10 scale model simulate precisely the conditions of the full-scale aircraft flying at 150 miles per hour.

The working section in which models are tested is 6 ft. in diameter. The air flowing through this section returns through an annular space surrounding it, being circulated by a fan. This requires a diameter of 17 ft. for the containing shell, which is made of steel nearly 2½ in. thick. The shell was designed and made by Messrs. John Brown and Co. Ltd., of Sheffield, and consists of four rings, each rolled from a single ingot, and jointed together by circumferential straps fitting over slight flanges on the ends of the rings. The four rings together form a cylinder 17 ft. in internal diameter and 32 ft. long. The ends of this cylinder are each completed by two steel castings forming a hemisphere. At one end is a special labyrinth packing through which the fan shaft passes to the external driving motor, while the other end has a door for access to the tunnel. The internal air passages forming the wind tunnel itself were designed at the National Physical Laboratory by tests on a small model, modifications being made until the uniformity of the air flow was satisfactory. In the actual tunnel, the internal structure is built entirely in steel, light castings being used in the curved portions, and steel plates on suitable framing in the straight parts. A honeycomb is introduced at the point of lowest air speed to straighten the flow, and is immediately followed by a rapid contracting jet just before the working section is reached. This results in very steady and uniform distribution of speed across the working section. The air is circulated by a metal airscrew or fan driven by a 400 h.p. motor. Air is compressed into the shell by three 400 h.p. compressors housed in an adjoining room, and capable of charging the shell to the full pressure of 25 atmospheres in about ninety minutes.

An observer cannot work inside the tunnel at this high pressure, and the readings of the balances on which the models are suspended have to be recorded outside. This is done by an extremely interesting and unique electrical apparatus which can transmit the readings to any point as desired. The air forces to be measured are balanced by electromagnetic attractions between coils of wire, the current in which is controlled from outside. The current required for balance is measured and thus gives a direct indication of the air force acting on the model. Certain movements of the model are also made by electric motors controlled from outside the tunnel.

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## Selectivity and Radio Communication*

IT has long been a commonplace remark that one of the greatest problems in the technique of radio communication is the avoidance of the reception of undesired signals. Improvement and developments in methods of reception have made it comparatively easy to receive intelligible signals from almost any transmitting station under a variety of conditions, but these methods increased rather than reduced the difficulties of eliminating interference due to signals emanating from stations other than the one from which it is desired to receive. For telegraphic communication the difficulty has in the past been partially overcome by increasing the selectivity of the receiving circuits so far as stability would permit, but the use of shorter wave-lengths and of directive aerial systems has also contributed to the solution. With the inception of broadcasting and

* F. M. Colebrook: "A Theoretical and Experimental Investigation of High Selectivity Tone Corrected Receiving Circuits", Radio Research, Special Report No. 12. (London: H.M. Stationery Office, 1932.) 1*s.* 3*d.* net.